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Subject:
Busseron Creek Mitigation Plan

ENVIRONMENT

Dear Mr. McGarvie:

Date:
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Peabody Midwest Mining, LLC (Peabody) is proposing off-site stream and wetland mitigation to compensate for temporal impacts to wetlands and streams associated with the Bear Run Mine (Amendment 5) project. After meeting with Peabody staff and walking most of the length of the original Busseron Creek oxbow stream channel during the Spring of 2012, the proposed restoration plan was developed for approximately 22,866 linear feet of Busseron Creek. This plan consists of the reactivation of approximately 14,450 linear feet of the original stream oxbow adjacent to the existing channel and establishing approximately 8,416 linear feet of restored channel within the existing dredged channel for low flow. Reactivation will occur by reconnecting the watershed to the meandering oxbow channel by clearly defining the oxbow channel through excavation work and incorporating a minimum of one earthen and rock plug into the channelized portion of Busseron Creek to direct flow into the meandering channel. Flow will be split at the plug between the restored remnant oxbow channel and the existing dredged channel. The optimum flow proportions will be determined with US Army Corps of Engineers Hydrologic Engineering Centers River Analysis System (HEC-RAS) modeling of the composite flow regime. This allocation of flow regime will establish the primary flow through the high value natural channel and provide flood routing through the dredged channel during high flow and a base flow component during low flow. The use of both channel sections will maximize aquatic habitat, function and value and is expected to increase diversity and abundance in aquatic communities due to increased habitat diversity and availability.

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This brief technical memorandum describes the benefits associated with restoration of Busseron Creek (Section 1.0) and the relatively larger ecological benefits associated with restoration of a larger watershed and stream system such as Busseron Creek compared to a smaller stream system, such as Buttermilk Creek

(Section 2.0) which is the off-site mitigation approved for the Bear Run Mine (Amendment 4) project. Summary and conclusions are presented in Section 3.0.

Section 1.0. Benefits Associated with Restoration of Busseron Creek

Busseron Creek is a large watershed draining approximately 138 square miles with an average annual discharge of 154 cubic feet per second (cfs). Based on the site visit during the Spring of 2012 and subsequent literature review and data analysis it is clear the aquatic habitat and channel form and function of Busseron Creek has been severely degraded by historic channelization, abandonment of the historic floodplain and changes to watershed hydrology through tile draining of agricultural fields and loss of wetland habitat. These impacts are evidenced by Busseron Creek being a deep, straight channel with steep spoil banks through the project site. As a result of channelization and temporary high sediment loads Busseron Creek experiences a reduction in habitat variability and substrate composition which have been found to be significant threats to aquatic life (Waters 1995). Results of the Busseron Creek bio-assessment show low abundance of benthic macro-invertebrates and fish for a perennial stream and most likely can be correlated to the reduction in pool/riffle size, and increased substrate homogenization. Furthermore, based on preliminary hydrodynamic modeling the approximately 2-year return period flood flow is contained within the high banks of the dredged channel indicating that the existing Busseron Creek channel is highly incised with significantly reduced channel/floodplain connectivity which results in degraded aquatic and floodplain habitat and ecological value as well as reduced water quality and attenuation of flood flows.

We believe that the potential is there to significantly improve the physical processes and aquatic habitat within Busseron Creek using the “natural stream channel” design method. The preliminary design approach and methods will emphasize restoration of physical processes that address biological limiting factors. The project goal is to restore physical processes that create and maintain a self-sustaining system. For example, instead of being focused solely on the use of structural habitat elements at site-specific locations (which will be incorporated into this restoration effort), the design approach will also emphasize using channel-floodplain interactions to increase the extent, depth, and duration of floodplain inundation. Restoring physical processes such as these will allow for the establishment and growth of riparian

vegetation so that, over time, wood will be naturally recruited to the floodplain and channel and thereby benefit aquatic species.

The specific design approach will optimize restoration potential while working within the existing physical and social constraints along the Busseron Creek project reach. The proposed restoration design will incorporate methods such as the following:

- 1) Reactivation of approximately 14,450 linear feet of the original stream oxbow adjacent to the existing dredged channel. This new channel will be designed such that overbank flooding occurs approximately once every one to two years.
- 2) Flow split between the restored remnant oxbow channel and the existing dredged channel to maximize available aquatic habitat.
- 3) Establishment of approximately 8,416 linear feet of restored channel within the existing dredged channel for low flow using installed habitat structures, such as large woody debris, construction of additional pool and riffle habitat, etc.

The ecological benefits of the proposed Busseron Creek mitigation are clearly presented in **Table 1**. Based on preliminary surveys of the existing Busseron Creek channel and the conceptual restoration plan, Peabody anticipates that the proposed off-site mitigation activities will result in the creation of almost 250,000 square feet of new pool habitat and almost 1,000,000 square feet of new riffle/run habitat within the reactivated channel. The existing habitat within the dredged Busseron Creek channel bottom (over 400,000 square feet) will be significantly enhanced under the proposed plan with the construction of additional pool and riffle habitat as well as the installation of in-stream habitat structures.

Table 1. Area of Aquatic Habitat within the Existing and Restored Busseron Creek.

Total Surface Area by Habitat Type (square feet)	Existing Busseron Creek	Restored Busseron Creek
Pool	0	244,080 ¹
Riffle/Run	0	911,920 ¹
Tributary	0	0
Channelized	420,800	420,800 ²

1. Distances scaled from profile in the Busseron Creek Mitigation Plan
2. No new tributaries are proposed, but there will be habitat enhancements in the channelized Busseron Creek

Based on a recent physical habitat assessment of the existing Busseron Creek channel it was found that habitat was limited by increased sediment deposition, low pool variability, low sinuosity and low bank stability/vegetative protection within the dredged channel. Such poor aquatic habitat is expected within channelized and dredged river systems with infrequent over-bank flooding. Conversely, the restored Busseron Creek is expected to have extensive areas of pool/riffle habitat, frequent over-bank flooding and a number of in-stream structures to provide immediate benefit to the aquatic system. Furthermore, as a result of the flow split between the existing and reactivated channel, the existing channel will experience lower flood flows, begin to build a more diversified channel within the high banks of the dredged channel. Peabody will install additional in-stream structures and construct pool/riffle habitats as further aquatic habitat enhancements within the existing channel.

As described above the proposed Busseron Creek off-site mitigation plan will provide significant and long-term ecological benefits and more than adequately compensate for the temporal loss that may be associated with impacts identified within the Bear Run (Amendment 5) area. In addition to the magnitude of stream length and wetland acreage created and improved within Busseron Creek, these off-site activities are significant in size and scope for the mitigation that will be established on-site (i.e. the permit area).

Section 2.0. Benefits Associated with Restoration of Busseron Creek

This restoration of Busseron Creek is expected to create almost 1.5 million square feet of in-stream aquatic habitat (**Table 1**). This amount of habitat creation is significantly greater than that provided by the Buttermilk Creek restoration project of little over 300,000 square feet (**Table 2**). It is important to note that though both mitigation efforts (Buttermilk and Busseron Creeks) provide for increased aquatic habitat, the primary reason for the difference in area of habitat created between these two projects is watershed size and the channel dimensions. That is, Busseron Creek is a perennial channel with an upstream watershed area of 138 square miles whereas Buttermilk Creek is an intermittent channel with an upstream watershed area of only 10 square miles. As a result, the restoration of Busseron Creek is expected to provide 80 square feet of high quality aquatic habitat per linear foot of restored channel compared to approximately 15 square feet of high quality aquatic habitat per linear foot of restored channel along Buttermilk Creek. Again, while both projects provide high quality restored aquatic habitat it is important to note that when

quantifying restoration efforts and benefits it is necessary to consider the area of habitat created versus simply the linear feet of channel constructed.

Table 2. Area of Aquatic Habitat within the Existing and Restored Busseron Creek.

Total Surface Area by Habitat Type (square feet)	Buttermilk Creek		Busseron Creek	
	Existing	Restored	Existing	Restored
Pool	0	122,692 ¹	0	244,080 ²
Riffle/Run	0	80,808 ¹	0	911,920 ²
Tributary	0	(41,508 Pool) ¹ (83,032 Riffle/Run) ¹	0	
Channelized	156,520	0	420,800	420,800 ³

1. Distances scaled from profile in the Buttermilk Creek Mitigation Plan
2. Distances scaled from profile in the Busseron Creek Mitigation Plan
3. No new tributaries are proposed, but there will be habitat enhancements in the channelized Busseron Creek

Section 3.0. Summary and Conclusions

Busseron Creek is a large watershed that has been historically impacted by dredging, channelization, agricultural and mining activities. Based on previous field visits, physical habitat assessments and hydraulic modeling activities the existing Busseron Creek is a severely degraded system with very little habitat diversity and infrequent channel and floodplain interaction. We believe the opportunity exists to significantly, and dramatically, improve the physical processes and aquatic habitat within Busseron Creek resulting in a self-sustaining system that provides for quality aquatic and terrestrial habitats and improved water quality.

In addition to the obvious ecological benefits associated with the proposed off-site mitigation plan for Busseron Creek the magnitude of the benefits is equally impressive. The amount of new mainstem habitat proposed for within Busseron Creek is over five times larger than that constructed within Buttermilk Creek. The difference in the amount of habitat created is at a minimum simply a function of watershed and stream channel size. That is, the Busseron Creek watershed is well over ten times larger than the Buttermilk Creek watershed, As such, the restoration of Busseron Creek is expected to provide 80 square feet of high quality aquatic

habitat per linear foot of restored channel compared to approximately 15 square feet of high quality aquatic habitat per linear foot of restored channel along Buttermilk Creek – a difference of over 5 times the habitat per linear foot of channel. In terms of the total area of habitat created, the Busseron Creek off-site mitigation has the potential to create over 5.5 times the habitat compared to the Buttermilk Creek project. However, this comparison is conservative and assumes that a single square foot of habitat within Buttermilk Creek is directly comparable to a square foot of aquatic habitat within Busseron Creek. A number of factors would suggest that Busseron Creek offers more valuable habitat when compared to Buttermilk Creek, including 1) proximity to Minnehaha State Fish and Wildlife Area, 2) Busseron Creek is a perennial channel whereas Buttermilk Creek can flow intermittently, 3) the size and quality of adjacent floodplain habitat, that is, much of the Buttermilk Creek floodplain is managed for agriculture whereas much of the Busseron Creek is bottomland hardwood forests.

While both projects provide high quality restored aquatic habitat it is important to note that when quantifying restoration efforts and benefits it is necessary to consider the area of habitat created versus simply the linear feet of channel constructed. The comparison of Busseron Creek and Buttermilk Creek presented here provides a perfect example of the value added when restoring larger stream systems and larger watersheds.